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ABSTRACT

This instructional package, one in a series of individualized instructional units on automotive steering and suspension, consists of a student guide and an instructor guide dealing with automobile alignment and adjustment procedures. Covered in the module are identifying positive and negative cambers, positive and negative casters, and toe-ins; recognizing the four most common adjustment procedures; and listing the adjustment procedures of the four adjustment methods. The student guide contains an introduction, a list of procedures for completing the unit, and an information sheet. Included in the instructor guide are an introduction, performance objectives, a list of references, suggested activities, a student posttest, answers to the posttest, and an instructional script. (MN)

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INSTRUCTOR'S GUIDE

PROGRAM: Auto Mechanics **UNIT TITLE:** Steering & Suspension

MODULE TITLE: Alignment Adjustment Procedures **MODULE NO.** AM-83-272

INTRODUCTION: Front-end repair and alignment is just one of the many tasks the automotive mechanic will be called on to do. As with any task, a thorough knowledge of the procedures involved is essential for an accurate job in the least amount of time. The procedures covered in this module will help the student to better understand the front end adjustment procedures covered in the service manuals.

PERFORMANCE OBJECTIVES:

The student should be able to:

1. Identify positive and negative caster, positive and negative camber, and toe-in.
2. Recognize the four most common adjustment methods.
3. List the adjustment procedures of the four methods covered in this module.

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Learning Groups Designed For:

- X **Adult**
- ____ **Special Needs**
- X **Secondary**
- X **Post Secondary**

Written By:

B. Spignesi 2/83

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TEACHING/LEARNING RESOURCES:

X Student Packet	___ Videocassette
X Instructor's Guide, Key, and Script	___ Film Loop
X 35 mm Slide Presentation	X Audiocassette
___ Filmstrip	

REFERENCES:

1. Factory Service Manuals
2. Stockel, Martin W., Stockel, Martin T., Auto Mechanics Fundamentals, The Goodheart-Willcox Co., Inc., 1982.

INSTRUCTIONAL METHODS SUGGESTED:

This packet is designed for individualized instructional programs where scheduling is open-entry/open-exit. However, these materials may be used to supplement traditional instructional methods. Tests can be used for pretesting for advanced placement of students who are already competent in this area. Demonstrations by the instructor are recommended to enhance student learning.

SUGGESTED ACTIVITIES:

These laboratory activities are included to enhance student learning and participation.

1. Check the alignment angles and adjust to specifications the following types of front ends.
   a. Shim adjustment method
   b. Cam adjustment method
   c. Slotted hole adjustment method
   d. Adjustable rods

The instructor will need to make equipment, materials and vehicles available for the student to complete these activities.

KEY

AM-83-272

STUDENT EVALUATION

ALIGNMENT ADJUSTMENT PROCEDURES

NOTE: Before taking this test as a posttest, you must have:

1. Read and studied the supportive material in this module.
2. Watched the slide/tape presentation AM-83-272 "Alignment Adjustment Procedures."
3. Completed the activities in this module.

INSTRUCTION: Complete each sentence with the correct word or words in each blank.

1. When the wheels are closer together at the front, this is referred to as TOE-IN.
2. The inward or outward tilt of the wheel at the top is the CAMBER angle.
3. The tilt of the steering axis to the front or to the rear is the CASTER angle.
4. Lengthening or shortening the strut rod located between the lower control arm and the frame changes the CASTER angle.
5. With the shim type adjustment, removing or adding an equal amount of shims from both attachment bolts changes the CAMBER angle.
6. To change caster on a shim type adjustment, REMOVE shims from one attachment bolt and ADD shims to the other.
7. Lengthening or shortening the tie rods will change the TOE-IN setting.
8. With the cam type adjustment on the upper control arm, turning both cams the same direction will change CAMBER.
9. To change caster on the upper control arm cam type adjustment, each cam has to be turned OPPOSITE directions.
10. To adjust caster and camber on some vehicles, the upper control arm attachment bolts are mounted through SLOTTED holes.

AM-83-272 ADJUSTMENT PROCEDURES FOR PASSENGER CAR FRONT-END ALIGNMENT - Script

1. This is a presentation of The Media Center, State Fair Community College, Sedalia, Missouri.

2. This is module AM-83-272, Adjustment Procedures for Passenger Car Front-End Alignment.

3. The car is on alignment stands and you have checked the alignment angles and found that they are incorrect and need to be adjusted.

4. In the alignment section of the shop manual, it will clearly show what method the manufacturer has chosen for adjusting the front end to compensate for normal wear.

5. This module will cover the different adjustment procedures based on the methods shown in the shop manuals.

6. After completing this lesson, you should:
   1. Identify positive and negative caster, positive and negative camber, and toe-in.

7. 2. Be able to recognize the four most common adjustment methods.

8. 3. List the adjustment procedures for the four methods covered in this module.

9. To adjust caster or camber, the control arm or strut has to be moved.

10. And to adjust toe-in, the tie rods have to be lengthened or shortened. So what we will now discuss are the methods which the manufacturer chose to make these adjustments possible. With that in mind, we can narrow it down to four methods.

11. 1. Shims

12. 2. Cams

13. 3. Slotted Holes

14. 4. Adjustable Rods

15. Before continuing with the actual adjustment procedures, let's review the three adjustment angles that are usually adjustable. These angles are referred to as caster, camber, and toe-in.

16. Caster, as viewed from the left side, is the angle of the steering axis from true verticle. Tilting the top of the strut to the rear, or the upper ball joint to the rear in relation to the lower, increases caster and is referred to as "positive caster."

17. Caster is decreased by tilting the steering axis towards the front and is referred to as "negative caster."

18. Camber, as viewed from the front, is the tilt of the wheel itself from true vertical. This view, exaggerated for clarity, is an example of positive camber.

19. Negative camber is just the opposite; the wheel is tilted in at the top.

20. Toe-in is the turning inward of the front wheels as viewed from the top in this view.

21. The first of the adjustment methods we will discuss is adjustment by shims. Shims are simply spacers. They can be seen in this view of an upper control arm.

22. Located between the frame and control arm shaft, the shims are held in place by two bolts which clamp the control arm shaft securely to the frame.

23. This is how the actual adjustment is made, As you can see, if the shaft bolts are loosened and the shims are removed from the front and rear, a gap is left between the frame and shaft.

24. If the bolts are tightened without shims present, they will push the control arm shaft outward, pushing the top of the wheel with it, and increasing camber.

25. Now observe what happens when we add shims to the rear and remove shims from the front.

26. The front of the control arm has been pushed outward and the rear pulled inward. This moves the ball joint end of the control arm to the rear, increasing the caster angle.

27. Multiple shims can be added and removed, making very accurate adjustments possible. The shims are available in thicknesses varying from 1/32 inch to 3/16 inch, in increments of 1/32 inch.

28. Another method of adjustment is the bolt and cam assembly/adjustment.

29. The holes in the frame brackets that mount the control arm are slotted to allow for necessary in or out movement of the control arm.

30. To adjust camber, loosen the nut on either the front or rear control arm bolt.

31. Using a wrench, turn the bolt forcing the cam against the inner stop on the control arm if the arm needs to go in, that is to decrease camber. This causes the arm to slide on the slotted hole.

32. To increase camber, turn the bolt the opposite direction, forcing the cam against the outer stop on the control arm. When the angle is correct, re-tighten the nut.

33. Adjust the remaining bolt the same way.

34. As with shim adjustment, turning both bolts an equal amount in the same direction moves the control arm in or out and changes camber.

35. Turning one bolt one direction and the other the opposite direction changes caster by shifting the ball joint forward or backward.

36. On some vehicles the upper control arm is not adjustable. Camber is adjusted by a single cam on the lower control arm.

37. Adjusting this cam moves the control arm and the bottom of the wheel with it, changing camber.

38. With this system, caster is adjusted by the strut rod which is fastened to the lower control arm and to the frame.

39. The strut rod is threaded where it attaches to the frame. The two large nuts lock the rod into position.

40. When both nuts are turned rearward, the strut rod is shortened, pulling the control arm forward and increasing caster.

41. Likewise, turning the nuts forward lengthens the strut rod, decreasing caster.

42. Adjustment of caster and camber is accomplished on some vehicles by shifting the inner control arm shaft on slotted mounting holes.

43. A special tool is inserted into the hole provided in the frame and hooked over the control arm shaft at the front or rear depending on which end is to be moved first.

44. Loosen the bolt holding the control arm in position and using the special tool pry the shaft, shifting the ball joint to the rear to increase the caster, to the front to decrease the caster.

45. After correcting the caster angle, shift both ends of the shaft in or out an equal amount to correct the camber angle.

46. With few exceptions, caster and camber are not adjustable on McPherson Strut front ends. Angles not within manufacturer's specifications indicate worn or bent parts that must be replaced.

47. A few manufacturers have provided for camber adjustment such as this eccentric bolt on the lower strut mount of a Plymouth Reliant. You should consult the manufacturer's service manual to find out if caster and camber corrections are even possible on other McPherson Strut front ends.

48. Let's move now to the steering linkage for the toe-in adjustment, the final angle to be checked and adjusted.

49. The inner and outer tie rod ends are screwed into a split sleeve. One tie rod end has left-hand threads, the other has right-hand threads. So, turning the sleeve one direction lengthens the tie rod; the other direction shortens the tie rod.

50. Before adjusting the tie rod sleeves to set toe-in, it is important to lock the steering wheel in the straight ahead position using a steering wheel locking fixture, as shown here.

51. Now loosen the tie rod sleeve clamps.

52. Using a special tool that hooks into the sleeve slot, turn the sleeves on both sides as necessary to adjust toe-in. Do not clamp locking pliers or a pipe wrench around the sleeve as this will crimp the sleeve and make it more difficult to turn.

53. After the toe-in is set, align both inner and outer tie rod ends

54. and tighten the sleeve clamps.

55. In this module we have attempted to cover general front end adjustment procedures. Because of the many variations in vehicle design, it is important that you use the information learned in this module along with the shop manual for more specific instructions on the vehicle you are adjusting.

56. Let us summarize the material covered in this lesson.

57. Caster, as viewed from the left side, is the angle of the steering axis from true vertical. Tilting the upper ball joint to the rear in relation to the lower ball joint increases caster and is referred to as "positive caster." Tilting the axis the opposite direction from vertical is "negative caster."

58. Camber, as viewed from the front, is the tilt of the wheel itself from true vertical. Tilting the top of the wheel outward increases camber and is referred to as "positive camber." Tilting the top of the wheel inward is "negative camber."

59. Toe-in, as viewed from above, is the turning inward of the front wheels. During an alignment adjustment, the front wheels are set to toe slightly in.

60. The four most common methods used in alignment adjustment are: shims, cams, slotted holes, and adjustable rods.

61. The adjustment procedures for any vehicle should be carried out according to the specifications of the manufacturer. You should be able to use the four adjustment procedures covered in this module.

62. (Credits)

63. (Disclaimer)

64. (Rewind)

STUDENT EVALUATION

ALIGNMENT ADJUSTMENT PROCEDURES

NOTE: Before taking this test as a posttest, you must have:

1. Read and studied the supportive material in this module.
2. Watched the slide/tape presentation AM-83-272 "Alignment Adjustment Procedures."
3. Completed the activities in this module.

INSTRUCTION: Complete each sentence with the correct word or words in each blank.

1. When the wheels are closer together at the front, this is referred to as _____.
2. The inward or outward tilt of the wheel at the top is the _____ _____ angle.
3. The tilt of the steering axis to the front or to the rear is the _____ angle.
4. Lengthening or shortening the strut rod located between the lower control arm and the frame changes the _____ angle.
5. With the shim type adjustment, removing or adding an equal amount of shims from both attachment bolts changes the _____ angle.
6. To change caster on a shim type adjustment, _____ shims from one attachment bolt and _____ shims to the other.
7. Lengthening or shortening the tie rods will change the _____ setting.
8. With the cam type adjustment on the upper control arm, turning both cams the same direction will change _____.
9. To change caster on the upper control arm cam type adjustment, each cam has to be turned _____ directions.
10. To adjust caster and camber on some vehicles, the upper control arm attachment bolts are mounted through _____ holes.

STUDENT GUIDE

PROGRAM: Automotive Mechanics **UNIT TITLE:** Steering & Suspension

MODULE TITLE: Alignment Adjustment Procedures **MODULE NO.** AM-83-272

PERFORMANCE OBJECTIVES:

The student should be able to:

1. Identify positive and negative caster, positive and negative camber, and toe-in.
2. Recognize the four most common adjustment methods.
3. List the adjustment procedures of the four methods covered in this module.

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INTRODUCTION

Front-end repair and alignment is just one of the many tasks the automotive mechanic will be called on to do. As with any task, a thorough knowledge of the procedures involved is essential for an accurate job in the least amount of time. The procedures covered in this module will help the students to better understand the front end adjustment procedures covered in the service manuals.

PROCEDURES

1. Read the objectives and introduction to this module.
2. If you feel you can pass a test over the objectives with 90 percent accuracy, ask your instructor for the pretest.
3. If you do not take the pretest or do not meet the minimum requirements on the pretest, continue with the next procedure.
4. Study the information sheets which are a part of this learning packet.
5. Observe and listen to slide/tape presentation AM-83-272, "Alignment Adjustment Procedures."
6. For additional information, refer to the following resources:
   a. Factory Service Manuals
   b. Stockel, Martin W., Stockel, Martin T., Auto Mechanics Fundamentals, The Goodheart-Willcox Co., Inc., 1982.
   c. Crouse, William H., Anglin, Donald L., Automotive Chassis and Body, McGraw-Hill Book Co., 1976.
7. Complete the activities which are a part of this learning packet.
8. Review the objectives to be certain you understand what you are expected to have learned. Performance of these objectives will be evaluated on the posttest.
9. Ask your instructor for the test over this module. You are required to achieve at least 90 percent accuracy on this test before proceeding to the next module.
10. When you pass the test with 90 percent accuracy, proceed to the next module.

INFORMATION SHEET

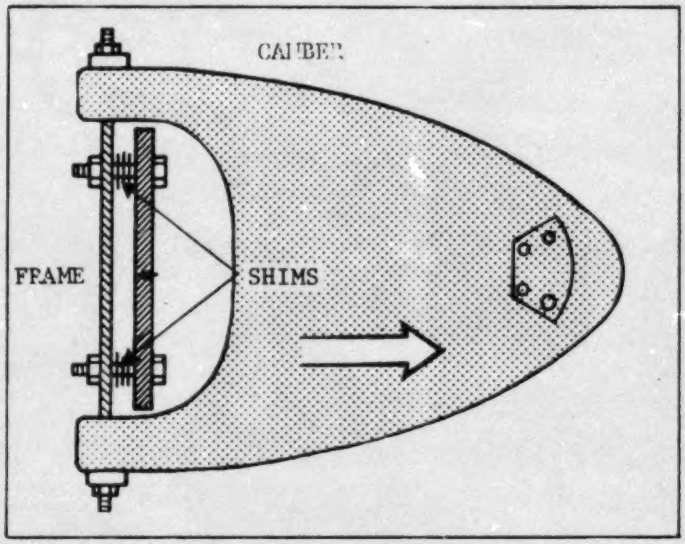
Doing a front end alignment requires that you have a thorough knowledge of the principles involved and the front end components that maintain the alignment angles. If you have any doubts about the function of any steering or suspension component or the purpose of any alignment angle, it is important that you review the appropriate module or textbook before proceeding with this module.

The adjustment procedures for aligning the front end will vary from car to car, but an understanding of the various methods used by the manufacturers to make adjustments possible, should make the alignment process easier.

The four common methods used to provide the necessary movement of the front end parts to make alignment possible are shims, eccentric adjusters, slotted holes, and adjustable rods. On checking the shop manual for vehicle alignment procedures you find a variation of one of these methods used on most vehicles.

The common method of using shims for adjustment is to mount the upper control arm shaft to a vertical mounting point on the vehicle frame. By placing a quantity of spacers or shims between the shaft and the frame, the adjustment for both caster and camber can be accompanied. The shims are available in thicknesses varying from 1/32 inch to 3/16 inch. The adjustment for both caster and camber can be accomplished with the shims. Adding shims or removing shims in equal amounts and thicknesses, both front and rear, adjusts the camber angle. Removing a shim from one end and installing it in the other end will shift the ball joint end of the control arm fore and aft, adjusting caster. An example of the shim type adjustment is shown in Figure 1.

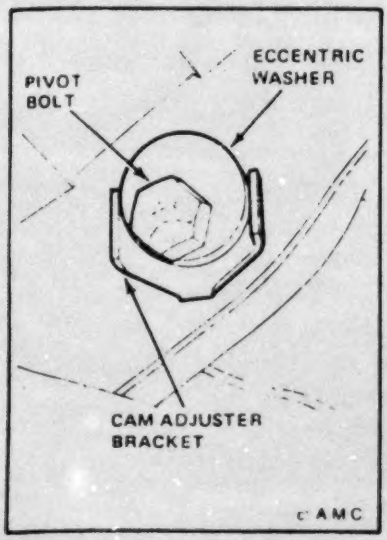
Figure 1 - Shim Type Adjustment



The eccentric adjustment method, shifts the control arm using an eccentric washer attached to a pivot bolt.

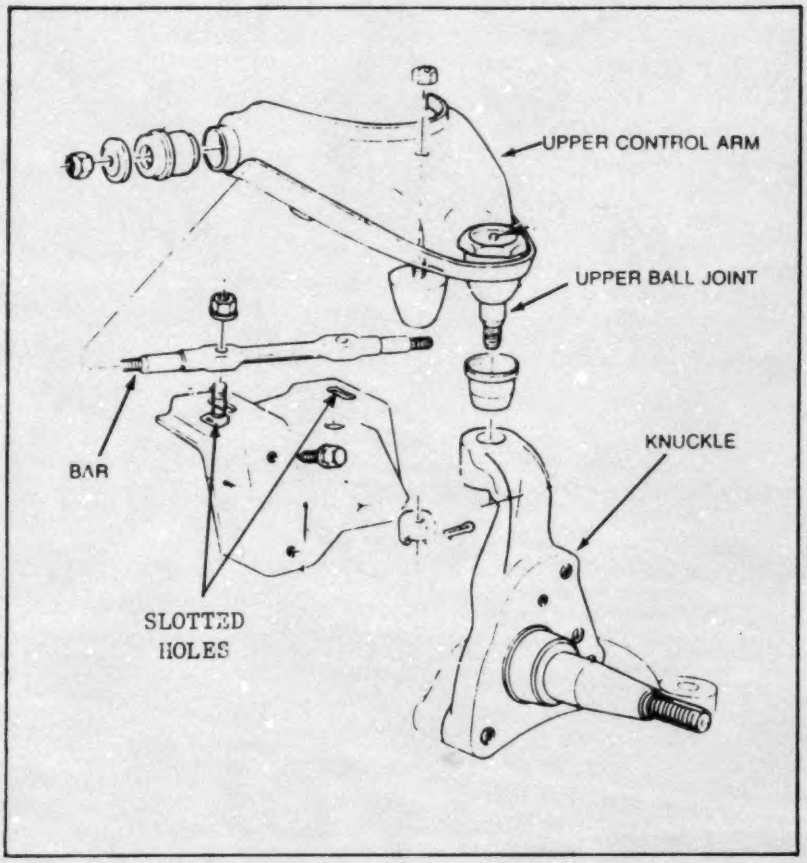
The bracket mounting the control arm to the frame has slotted holes. A cam adjuster bracket is welded to the control arm bracket. The eccentric or cam when rotated is forced against the cam adjuster bracket, forcing the control arm pivot bolt to slide in the slotted hole. When used both front and rear on the upper control arm, both caster and camber can be adjusted. See Figure 2.

Figure 2



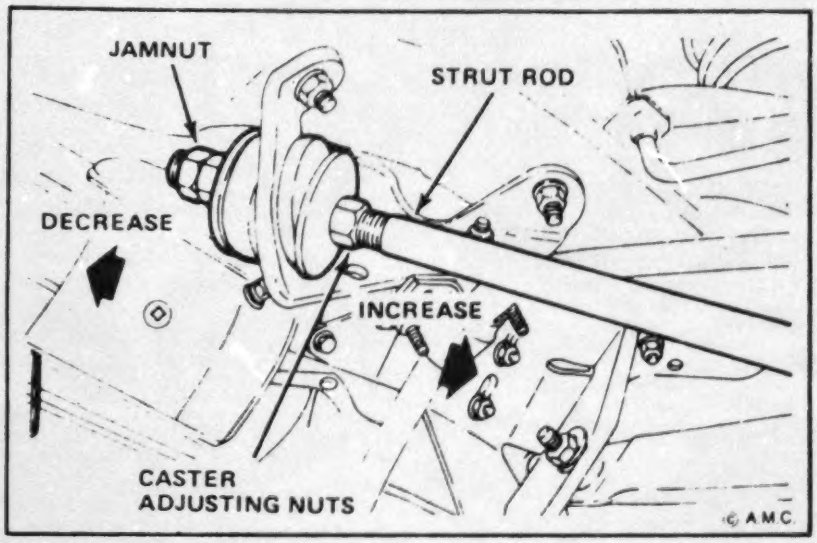
On some vehicles, the upper control arm shaft is bolted through slotted holes in a horizontal surface of the frame. By loosening the mounting bolts and sliding the shaft in or out in the slotted holes, camber can be adjusted; moving one end in and the other out, caster can be adjusted. See Figure 3.

Figure 3



Caster adjustment is accomplished on some vehicles with a beam type lower control arm by shortening or lengthening the strut rod. The strut rod attaches to the lower control arm and through rubber bushings to a part of the frame. When the strut rod is shortened, it pulls the control arm forward, increasing caster. Lengthening the rod pushes the arm back, decreasing caster. Nuts threaded on the rod on either side of the frame attaching point make the adjustment possible. See Figure 4.

Figure 4



Adjustable rods are also used in the steering to adjust toe-in. They are the tie rods and are in three sections. Each end of the tie rod has external threads, one left hand threads, one right hand threads. An internal threaded sleeve joins the two ends together. Clamps squeeze the sleeve which is split to the threads on the ends to lock it in place. Adjustment is accomplished by loosening the clamps and turning the sleeve. Depending on the direction the sleeve is turned, the tie rod is lengthened or shortened, changing toe-in. See Figure 5.

Figure 5